Statistics Lecture 1

Psychology Statistics (University of Nottingham)

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Designing Experiments:

- Begins by formulating a number of research hypotheses
- Translate the different research hypotheses into a set of treatment conditions and the selection of an appropriate experimental design within which to embody the different treatment conditions
- Different treatments are administered to different groups of subjects or to the same subjects in different orders and performance on some response measure is observed and recorded

Independent and Dependent Variables:

- Independent variable
  - Treatment variable
  - Variable that is manipulated
    - ⇒ drug or placebo
  -
- Dependent variable
  - The measure
  - The response measure which is manipulated on the basis of the independent variables
    - ⇒ blood sugar levels

Quantitative, Qualitative & Classification Independent Variables:

- There are three kinds of independent variables:
  - **Quantitative variables**- variables that represent variation in amount (e.g. amount of drug, loudness of noise).
  - **Qualitative variables**- represents variations in kind or type (e.g. teaching strategy).
  - **Classification variables**- systematically vary characteristics which are intrinsic to the subjects of the experiment (e.g. age, sex, IQ, species, word type, etc.)

Nuisance Variables:

- Nuisance variables are potential independent variables, which if left uncontrolled could exert a systematic influence on the different treatment conditions:
  - Several researchers running the same experiment might produce an experimenter effect.
  - The time of day could have an influence.
  - The kind of subject selected can affect the influence of the independent variables.
- If we do not control for these differences in experimental situation, we might have a confounding variable in the experiment.

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Dependent Variables:

- Once we have designed an experiment and have produced an experimental hypothesis then we need to decide upon the specific details of the experiment.
- The idea is to select a measure that will "capture" the hypothesised differences.
- The measure that is adopted is known as the dependent variable.
- We hypothesise that the observed data will be somehow dependent on the nature of the independent variable.

Control in Experimentation:

- Consider an experiment where the data is collected by running the experiment simultaneously in two different laboratories:
  - The two labs are identical in every respect except that the temperature for each room cannot be controlled.
  - Temperature variations may lead to systematic variations in the performance on a task.
- Randomly allocating different treatment conditions to the rooms gives an equally likely "chance" that different random temperatures will be associated with the different treatment means.

Completely Randomised Designs:

- The completely randomized design is characterised by the fact that the subjects are randomly assigned to serve in one of the treatment conditions.
  - ⇒ Also known as a **between subjects** design since any differences in behaviour observed among the treatment conditions are based on differences between different groups of subjects.

Randomised Group Designs:

- Randomised block design uses blocks of subjects who are matched closely on some relevant characteristic
- A common procedure is to treat a subject as a 'block', wherein the subject serves in all the treatment conditions of an independent variable
  - ⇒ When subjects complete all the treatment conditions this type of design is commonly referred to as a **repeated measures** design or a **within subjects** design.

Statistical Hypotheses:

- The Null Hypothesis
- The Alternative Hypothesis
- Deciding to Accept or Reject the Null Hypothesis.

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- Errors in Hypothesis Testing.
- Juggling Type I and Type II Errors

Statistical vs. Research Hypotheses:

- **Research hypothesis-** is a fairly general statement about the assumed nature of the world that gets translated into an experiment.
- **Statistical hypotheses-** consists of a set of precise hypotheses about the parameters of the different treatment populations.

The Null Hypothesis:

- Is the statistical hypothesis that will be tested
- It is often symbolized as H_o.
- The function of the null hypothesis is to specify the values of a particular population parameter (usually the mean) in the different treatment populations (symbolized as μ_1, μ_2, μ_3 and so on).
- The null hypothesis typically chosen gives the same value to the different populations such that
  - ⇒ H_o: $\mu_1=\mu_2=\mu_3$=etc.
- This is the same as saying that no treatment effects are present in the population.

The Alternate Hypothesis:

- If the parameter obtained from the treatment groups are too deviant from those specified by the null hypothesis, H_o, then the null hypothesis is reject in favour of the other statistical hypothesis, called the alternative hypothesis, H_1.
- Usually the alternative hypothesis states simply that the values of the parameter in the different treatment populations are not all equal. Specifically,
  - ⇒ H_1: not all μ's are equal.

Deciding to Reject the Null Hypothesis or not:

- A decision to reject H_o implies an acceptance of H_1, which in essence, constitutes support of our original research hypothesis
- On the other hand, if the parameter estimates are reasonably close to those specified by the null hypothesis, H_o is not rejected
- There is a problem with the way in which the null hypothesis and alternative hypotheses are set up.
  - For the null hypothesis- All μ's are equal
  - For the alternative hypothesis- All μ's are not equal
- These are statements at the level of the population means. However all we have are sample means
- We have to adopt a criterion for rejecting the null hypothesis
- We do this by calculating test statistics based on the properties of the F-distribution

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- The value we adopt is called the significance level and is referred to as a (alpha)
- The value that we usually adopt in psychology is 0.05

Errors In Hypothesis Testing:

- The procedures we follow in hypothesis testing does not guarantee that a correct inference will be drawn
- Whenever we make a decision about the Null Hypothesis we can make a mistake.
- There are two basic kinds of errors:
    - **Type I Error**
    - **Type II Error**

Type 1 Error:

- Reality
- Null Hypothesis is true
- Alternative Hypothesis is false

- Decision
- Reject the Null Hypothesis
- Accept the Alternative Hypothesis

Type II Error:

- Reality
- Null Hypothesis is false
- Alternative Hypothesis is true

- Decision
- Fail to reject the Null Hypothesis
- Reject the Alternative Hypothesis

Summary of Type I & II Errors

		Reality	
		H_o is true	H_o is false
Decision	Reject H_o	Wrong Type I	Correct
	Fail to reject H_o	Correct	Wrong Type II

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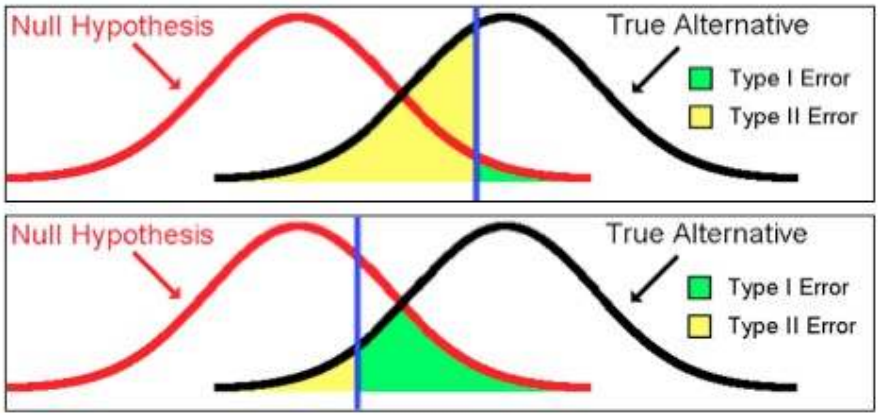
Trading off Type 1 & Type II Errors:



Juggling Type I & Type II Errors:

- Most of the time we do statistical analyses we are trying to juggle Type I and Type II errors
- Generally, if it is important to discover new facts, then we may be willing to accept more Type I errors
- On the other hand if it is important not to clog up the literature with false facts then we might be more willing to accept more Type II errors

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